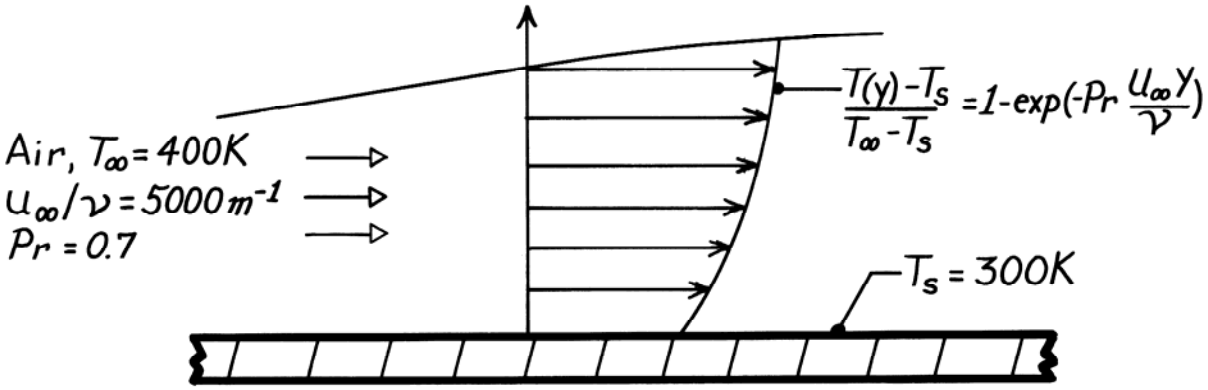
PROBLEM 6.3

KNOWN: Boundary layer temperature distribution.

FIND: Surface heat flux.

SCHEMATIC:



PROPERTIES: *Table A-4*, Air (T_s = 300K): k = 0.0263 W/m·K.

ANALYSIS: Applying Fourier's law at y = 0, the heat flux is

$$q_s'' = -k\left.\frac{\partial T}{\partial y}\right|_{y=0} = -k\left(T_\infty - T_s\right)\left[\Pr\frac{u_\infty}{\nu}\right]\exp\left[-\Pr\frac{u_\infty y}{\nu}\right]\Bigg|_{y=0}$$

$$q_s'' = -k\left(T_\infty - T_s\right)\Pr\frac{u_\infty}{\nu}$$

$$q_s'' = -0.0263\ \text{W/m}\cdot\text{K}\left(100\text{K}\right)0.7\times 5000\ 1/\text{m}.$$

$$q_s'' = -9205\ \text{W/m}^2. \qquad <$$

COMMENTS: (1) Negative flux implies convection heat transfer to the surface.

(2) Note use of k at T_s to evaluate q_s'' from Fourier's law.